# The

# National Geographic

# Magazine

## AN ILLUSTRATED MONTHLY

Date: JOHN HYDE

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#### Assessment Editors

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Assistant Emba Gilblint M. GROSVENOR, Washington D. C.

中各位员 PHYSICORAPHY OF THE RECERACION CANAL ROUTE With program and these and triest attorns. C WELLARD MAYES. 233 STCARAGUA AND THE INTEMIAN ROUTES A P DAVIS 247 With illustrations. THE WELLMAN POLAR EXPEDITION. J BOWARD GODE 397 THE COAST AND GEODETIC STRVET; ITS PRESENT WORK H D PRESTON 268 EXPLORATIONS IN ALASKA 200 METROPOLOGY IN THE PHILIPPINES. 271 The Mission of the Dison p. 273 Occupied Literature Jackson a A Phonesall

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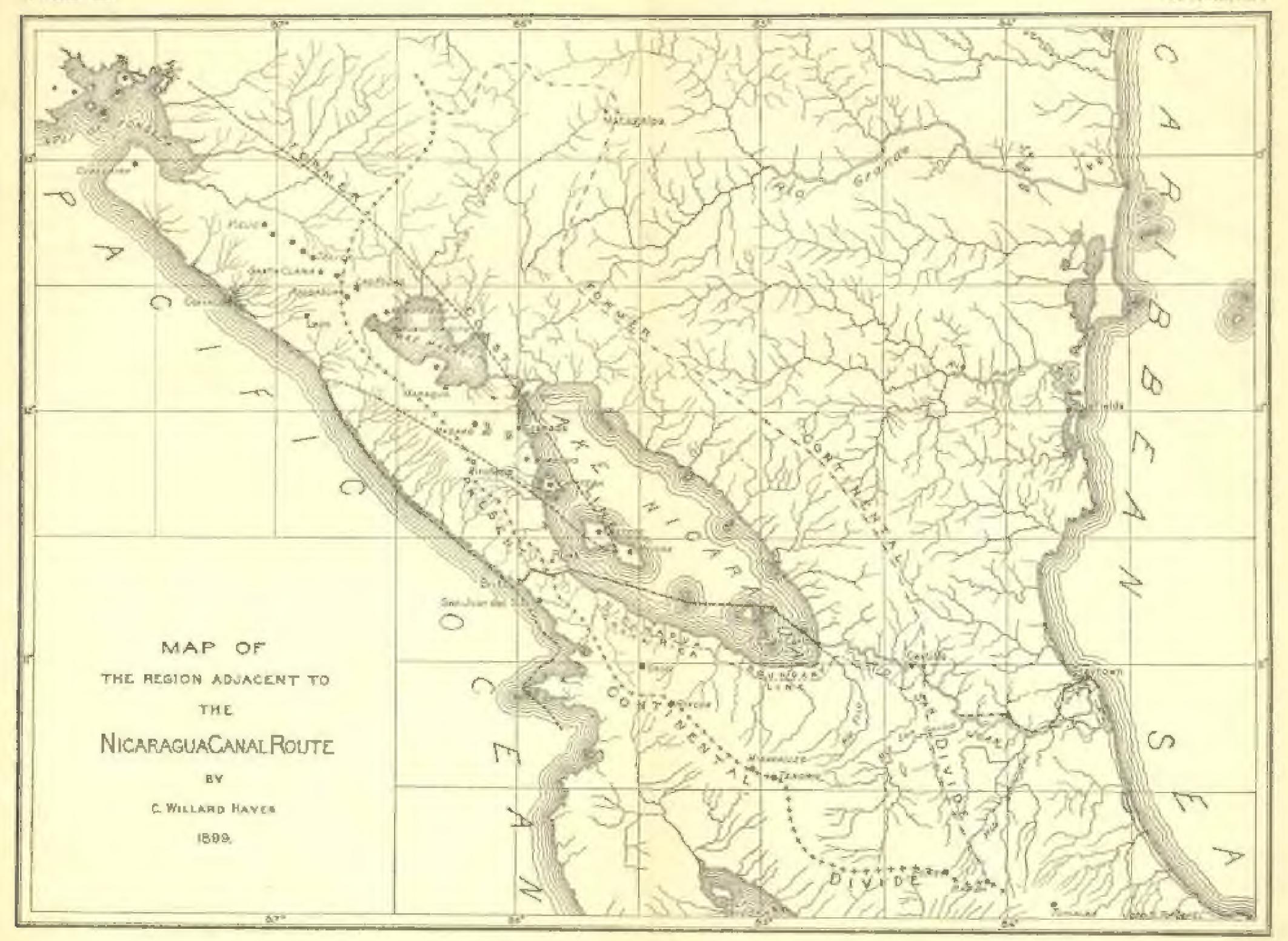
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On Nurse Discoveries in America.



#### THE

# National Geographic Magazine

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## PHYSIOGRAPHY OF THE NICARAGUA CANAL ROUTE

By C. WHEARD HAYRS,

Lailed States Contagnent Source

The region whose topography and geology have a most intimate bearing upon the problems connected with the proposed Nichthauth cuttal embruces northern Costa Rica and southern Nicaragua. It is sharply limited on the south by the high volcame range of Costa Reca, which ream its massive form diagonally nerous the isthmers. It is limited to the north somewhat less definitely by the increasing bright of a deeply dissected platents. which precess with the mountains of northern Nostragua. tween to see limits lies a broad irregular depression, which extends very mearly across the isthmus in a diagonal direction parallel with the Costa Rienn range. This depression is more occupied charity by Atlantic drainage, the continental divide lying within a short distance of the Pacific. It contains the brains of Lakes Nicoragua and Managua and their outlet, the San Juan river. It is important to note that the Nicareguan depression is not a souple river valley. The portion with which we are closely concorned, that lying between the lake and the Caribbean embraces. two statues draining bearns, whose streams formerly flowed in opposite directions, although by a goologically recent reversal of the drainage they now have a single outlet to the sea.

When examined in detail the surface of the Nicaraguan depression presents considerable relief, and its topographic features maturally group themselves into three classes.

Extending from the base of the Costa Bican volcanoes northward to the San Juan river and beyond are many hills whose

summits reach a tolerably uniform elevation on north and south lines, but increase in height from either aide of the isthmus to ward its axis. In the vicinity of the San Juan these hills have steep stopes and rounded summits. Some distance back from the San Juan the valleys which separate them are merower, and there are considerable areas of level or undulating surface at an altitude corresponding with the summits of the hills nearer the center of the depression. It is evident that if the valleys were filled even with the summits of these hills, there would be formed is broad undulating plain, sloping gradually up from either side toward the axis of the isthmus. It is entirely probable that such a plain cure existed and that it has been converted into a series of even-topped hills and ridges by the subsequent cotting of stream channels below its surface. The number in which this place was originally formed is manifestly by the long continued action of streams when the land stood considerably lower than now that is by the process of stream degradation or baseleveling. It was therefore a gradational, not a constructional, plain. If it were reconstructed by the filling of the stream valleys, its present attitude would vary between 100 and 200 feet.

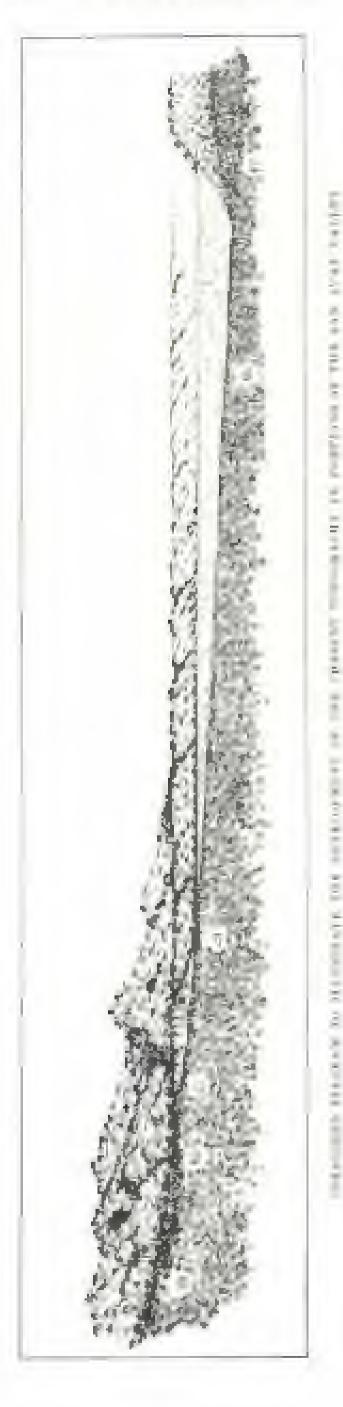
As imbreated above, numerous valleys now intersect the surface of this old plain. Except in the case of the San Juan they vary with the size of the stream which they carry. The reasons for this exception will be pointed but later. The ralleys are broad in proportion to the extent to which the old plain has been destroyed, and they grow narrower with increasing distance from the axis of the depression. The smaller streams generally head in autrow gorges. In some cases they have not completely disrected the old plan, but flow upon its surface in shadow varieys. which, lower down, give way to marrow garges, and these in turn to the rather wide alluvial valleys near the trunk atreum. The greater part of the erosion which has dissected the surface of the old plain was accomplished when the land stood somewhat higher than at present. The vaileys were then much desper and none had extensive floodplains, except perhaps the largest streams near the sea. The recent change in the sittede to the land has brought the valleys below sea-level, changing the rivers from corrading to aggreding streams. They have since allted up the estuaries which were thus formed, producing the wide alluvial plains through which they now meander.

Corresponding in some degree to the ralleys incised within the oil plain are eminences raing distinctly above its surface.

These are residual hills which, by reason of the harder rocks of which they are composed or their position on the divide away from the main dramage times, were never reduced to the level of the plain. Where the plain was best developed, that is near the sea margin on either sale, these residual bills are indequent and inconspicuous. To the southward of the San Juan, in the region lying between the Samplyon and the San Carlos, there is ness no extremive area to which the bills are almost wholly rensmants of the disacted plant, their summits in general presenting but little variation in altitude. To the northward of the San Just the resolunt falls accor with increasing frequency and greater altitude, and finally merge with the mountains of morthern Nammgon. They also increase in number and height from cother sale of the isthmus toward its conter, being most all made at along a line which crosses the San Juan valey in the vicinity of Castillo. If the old plain were reconstructed by the filling of the present valleys, it would not be continuous across the lethning, but its easiern and western portions would be separated by an irregular line of these residual hills, the low gaps between

them being slightly above the level of the plain.

The relations of these three classes of topographic forms will purhaps be made sumowhat greater by a reference to the accornpunying alculized exciels and section on page 236. The surface of the peneplara is indicated by the even summits of the helfs to the right. Residual hills are represented to the left, rising about thy and distinctly above the sarries of the peneposin. The profile shows a transverse section of the San June entire and a longitudinal section of the valley of a tributary stream. The latter is represented as rising in the residual hills to the left. and flowing for some distance in the narrow gorge a h. From b to c the stream flows in a broad shallow valley at about the level of the peneplain. From e to d it is in a narrow gorge recently cut and still being actively despended within the peneplain. It omorges from this gorge at of and thence to the conregio of the main river valley at c it mounders through an allumnt plain continues with the San Juan floodplain of. The bottom of the valleys which the tributary and the trunk stream overnied before the recent theoression of the region is represented in the profile by the solid line between the alluvium and the underlying cook. When these valleys were formed they were considerpoly above sea-level and the streams had a much more rapid fall than at present, but they are now somewhat below sea-level.



Samming up the foregoing statements very briefly, it appears that the surface of the Nichragians depression consists of a broadly undulating plain formed by the crusion of streams flowing to the Pacific and to the Atlantic from low gape at the divide. Above this plain are residual hills, most abundant at the axis of the istleinus, where the continental divide was formerly besited, but increasing in height along the nois toward the north, where they merge with the mutatains of northern Nicaragua, and finally, there are many valleys which have been out in the surface of the plain by the erosion of streams after the region had been elevated to a higher altitude. The lower protions of these valleys have subsequently been drowned and sitted up with the formation of broad alluvial fleodpiains.

During most of the time in which these topographic features were being developed the Pacific coast had an outline very different from that which it bas at present. Lakes Nicarneus and Managua then had no existence, and the region which they now occupy was in pack the basins of streams flowing to the Pacific, in part open ocean, and in part a bay which then instented the Pacific court and whose southern point was near the present island of Madera The relations of the present and former coast lines are shown on the accompanying man, plate 6.

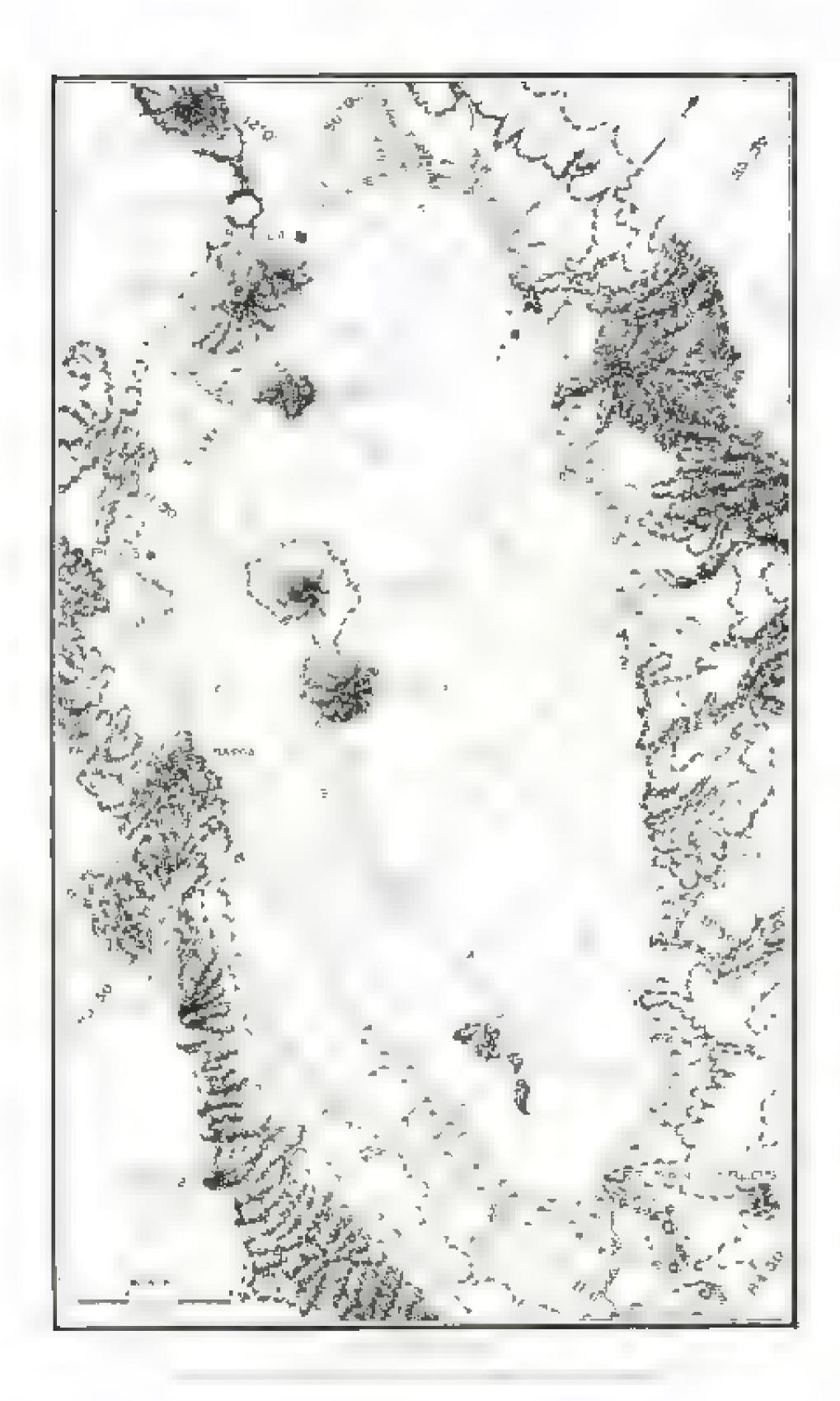
Lake Nicaragua has a regular oval outline, its longer axis extending about northwest-southeast. Its area is very nearly LOOD square miles, and the mean elevation of its surface is about 104 feet above tide. Its shores present considerable diversity, depending chiefly on the character of the rocks which form them and the direction of the prevailing winds. The trade winds blow with great persistency throughout a large part of the year. They are deflected from their normal course by the high volcanic range of northern Costa Rica, so that hestend of being northeast winds they vary from east to east-southeast. As a result of this constant wind direction the southeastern end and northeastern side of the lake rarely experience any surf, and benea those portions of the lake shore lave bu beach, but are bordered by swamps, with regetation constantly envioaching upon the lake. Along the southwestern side and western end of the lake, on the other hand, there is a constant heavy surf and as a result a broad sand beach, generally backed by a wave-cutchill. The accompanying map (page 239), based upon curveys made by the U.S. Nicaragua Canal Commaission, shows the configuration of the lake basin. The most interesting feature shown is the old channel, evidently a drawned river channel formed when the southern half of the lake basin was dry land. This channel marks the course of a river formed by the union of the several streams now entering the lower and of the lake with the one which occupies the upper portion of the San Junu valley. It is first detected in the vicinity of the Solentiname islands, and if it was over excavated between this point and the mouth of the Frio this portion has subsequently been filled by sodiment brought into the lower and of the lake. From the Solontiname islands for about 10 miles partlewestward there is only a slight indication of the channel. Thence to the base of Machera it is continuous and distinct. The greatest depth in the lake, over 200 feet, is near the western end of this channel.

formerly indected the Pacific coast, was a long cape or perimenta. This now forms a part of the marrow strip of land excepted by the continental divide between Lake Nicaragua and the Pacific. This part of the Esthmus, although intimately connected with the Nicaraguan depression, is not properly a part of it. Its topography is particularly interesting in connection with the topography is particularly interesting in connection with the topography is particularly interesting in connection with the possess capal since it contains the lowest gap in the communical divide between the arraits of Magellan and the Arctic ocean.

The manner in which this gap was developed is worthy of con-

Bordering the jake along its southwestern side is a very perfectly baseleveled plate from five to eight miles in width, which I have called the fives plate (see map, page 242). This is probably a portion of the same peneplain which forms the fundamental topographic feature of the Nieuraguan depression, and was as one time doubtless continuous with it. From the take share where the waves have cut a narrow terrace backed by a low cliff, the plain ascends toward the southwest at the rate of about 8 feet per mile. Its even surface is interrupted by occasional low resolual knobs, which increase toward its inner margin, passing into the continuous ridges and high hills of the main continental divide. The Tola hills which border the firms plate on the southwest here extend to the Pacific, although further toward the northwest a narrow coastal plate is developed similar to the Rivas plain on the opposite side of the mage.

The Tola hills doubtless correspond to the residual hills which rise above the peneplain of the Nicaraguan depression. They have a serrate outline, the altitude of their summis varying botween SIR) and 1,800 feet. While this range of hills still formed a long, narrow point of land between the buy of Namogous and the Psciffe, the effect of deformations and wave erosion was such as to make the position of the divide unsymmetrical. As shown on the map it was for a time located very much nearer to the Pacific than to the head of the hay. Hence the streams which headed upon the divide and flowed in opposite directions were of very unequal length. Those flowing east to the buy must have been five or six lines longer than those flowing west to the ocean-Such conditions rendered the divide unstable and the familiar process of shifting toward a position of stable equilibrium took place. A stream accupying the position of the lower portion of the lin tirands, by reason of the advantage which it possessed in having its fall concentrated within a short distance, out back into the divide and diverted to its own basin successive portions of the opposing stream. At the beginning of the process on eastward-flowing stream overpied the valleys of the present Tola, upper Rio Grands, Guiscovol, and lower Las Layer. A small tributary headed against the Pacific stream on the divide in the vicinity of La Flor. This tributary was first reversed and then the upper portion of the original stream, the present Tola, was divorted toward the southwest. The same process was continued



I it is die die la mas puebed back to its present position at he streams to the airthward also as dered some assert to refer Thus upper translations of the blocks and too issues were rejected, forming portions of the present market, on Make 426, and those area. The deserted ever values formarks on upted by those of Tolamid Cascabel, and from which have next belief Guisnoyol now those, forms the cowest gap in the cost to up it. divide Its survivit is 154 feet a new good value, at I it is exact a so good in from a there are that accounts insurant work is required to be a swarm right. I many the wet season the gap is occupied by a swarm right of the city of the cater appears to how out that is taken and Pa. A.

The map (put e fig. in words the present on I former constinces are represented, shows that a large land over his regardly see and led to the partion of the solutions. The to make the estimate of the Schooling in the estimate described. The actor is an obtained, and as surface for a sure those developed by the processes of a loss one degree data in. The former, on the other hand, is a opesed of materials recently a great from a feature to read, it is a opesed of materials recently a great from a feature to read, it is a opesed of materials recently a great from a feature to read, it is a opesed of materials recently a great from a feature to read.

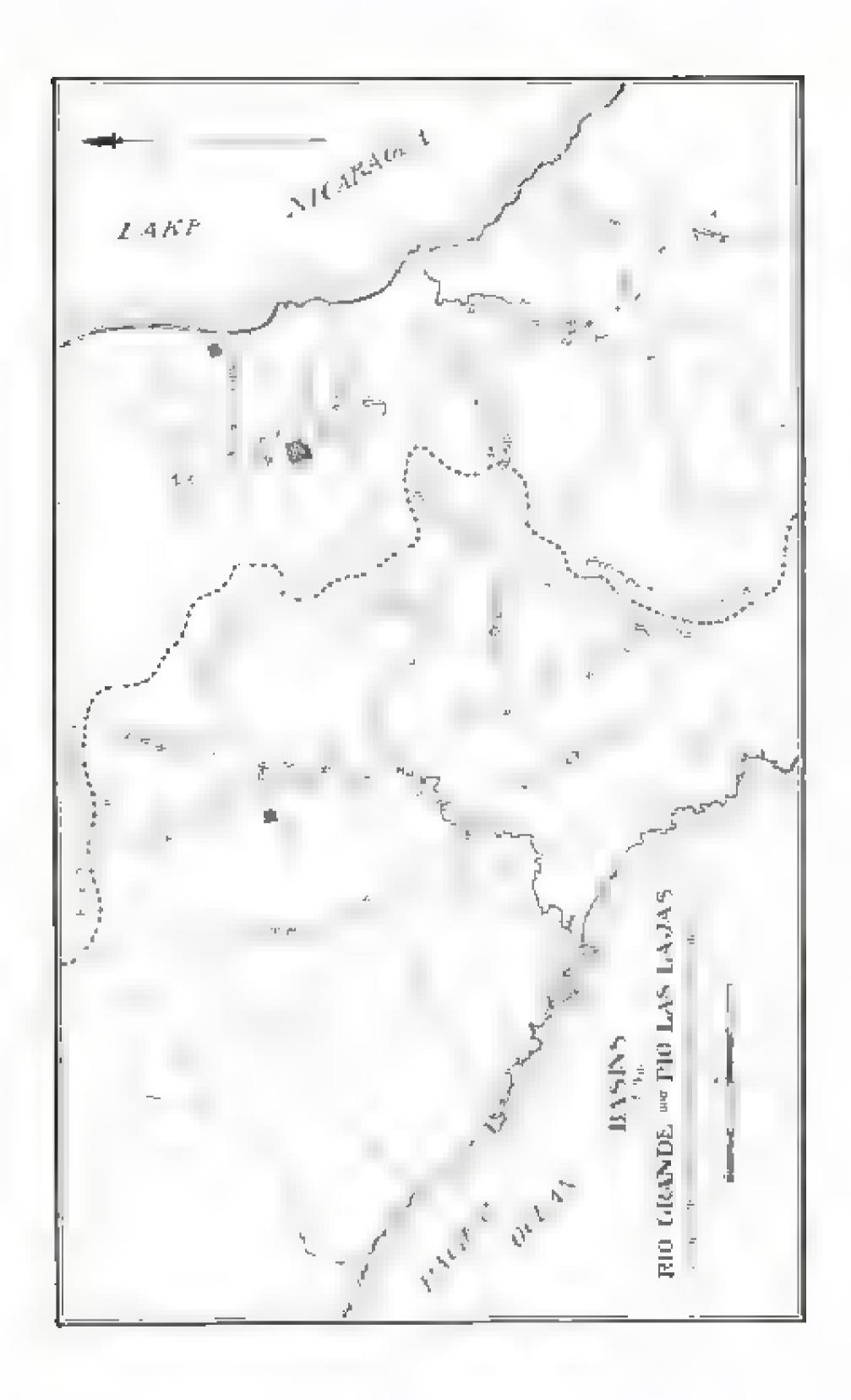
Extending through the concret to accurate question is a losof we wanted, all of which are gerlogically very receive walls. some are att. delive. From these numberous verte, was in were at the tautemand or a visit at of other atomat has need empted u is ng an becau, gent ye oping platease, fiyu whata tue nove or less at a had and a not out as. The southers, you fithes, volcannes are the awin peaks of Malera and Constepe, which obesity my sayed in Luke Nichtugha. Loward his continued are Zupater, also it as mand. Ma macho Monya, Cadte, e. 3 otas. tombo, the clastered peaks forming the Mart are fatget at a Paper Lasegaran on the Light of Fonseca. Most o these visearlies have excepted but the one of Laynean fong nested a sterial, the injectionrying from course blocks of so it late to be a new ded. It is to a fragrounded material which gives to three you rangement has the satisful exercise policy for the all those with the rayer need record y active, as theretege and Mount do to, are mades portion is the effects of energy, it werer are seen an inbefore the talenate and vity comecs, bull the extra cory of the gomes is another destroyer. The details of octions at the asaconcervary were year to year. When the base backer at has contrem ved or a othfield verseinnt the spin mits assure the

properties restricted from seen in Marteta and Zapatero. In some cases the related moment to destroyed, not by the slower course of erestina, but by an explosive eruption. The result is an irregular pagged translater of the cone, issuitly with a destroyed in the center occur, ted by a lake. This form is seen Mandar to and Cosego on. Therefore a supplemental time to the foreign was occur accounted peak, and the result known, the same, thof Coseco on was blown off by an explosion court in the 1943, the cose of a cut recorded cruption and bearing seed by that if Kase one in 198

the open of Lake Sciences in a relevel plain when stretches from the open of Lake Sciences in a releves word of the fault of his seria. It is not possed with a region of frequents of probably in the form of all flows. The tratefactors are not sorted though successive layers are separatively that are places. In a quarry near Matagon and an tracks have insertioned in the internal showing out it is very recent and also afforming some the reason of the physical roads. Is under which it was deposited. To the source of the physical roads, as placed and se monted from it by a rather steer

or ment is a plateau which slopes somewhat gradually from an at the of about 1,200 feet along its a mer margin southwest-ward to the Phothe coast. This plateau is composed of exactly the rame materials as the lower plant to the east, and it at pears to make that the two south estates or new continuous, but have receively been separated by a last.

brown as the even a neet me for outside oil, tapposes probable I structure corts I steary true the waters of the Athestic and Paralle had free macron man remains agrees the position of the will have I are glockly negroes a stary realist work were not a mission ever a considerative portion of the added te and great ransies of voluence rocks were pented but upon them. In ruddie Tertary. time there, ou was e evaled a nore sea, evel and there is no eveor two it has a been able by anore at the boren the research an earth given the contains the bed between the woomen as the elevation of the fight a was followed by a long period of ension, during wi as something when reduced to a broad rank anathog place trait, day low sitted near the axis form the house and from the d y to stress ≠ Bowel it procets I rections reasonable the tural assessed wastward to the any which in he to his findic group. After the strace. If the contactry had been considered a reduced nerose that parrowest pertion of the estle his the region



enforced and therefore chesistems. The streams were thereby as to desited and Legan to treach the surface of the base evelor variety which they had previously formed. Short yafter this essential places was a received of the volences acceptly, where had ness Income at for at long tone. This second distanct partiod of a safety. has court and own to the present targe. It was man esterall by two meanly parallel lines of verits. One of torse lines gave rigo to the Costa Physiq volumes a range, it all the other thicker raging a mage. The veries form the late latter ware so make is. They among od a line nearly parallel with the far aftercoast, terregarden to the southware, near the southern ear of the say. when then in autom to the Seconds. Vast quiest uses of late and ask of were to cown out from these wents and choose on was so I last the operior, goet mals formed a dam, cut mg If the my from the seems by he the precipitation was greater than the evaporation, the waters or accted behind the partice. part as the reaction was grad andy recent, our much od upon a se because of the street as we see had been trebutray to the easy. The water dealthess gar a ped to escape westward for a long toward after the rol mane act vity began, but are sees to emptione raised the last so such a neight coast dee-Crand a gap of the continue tall wale, which was lower builthe an to the westward. They then escaped gastward to be Atlarine. The could entitle divide, which ladd prevents your special on the property there appears in fighting out their pay were alternatively take souther and a present position theory the Papake exact west of the Likes. When the waters of the lake first every in led the co- to to atally will of they were disabilities considered whiigher tead at tese t. The tag erad fore any headers a, however were reads and they are leaply weathered rock, and the titlet was quickly

The intest episode in the geologic hest my has been the degrees on the portion of the esthants to the extent problem to the portion of the bundled feet. By the depression the lower particles of the error we says were now red, form up togic discontinues. The screen rate wing to the Particle Lavett most ensessentirely then there exists with section ent. Thus the has been exacted tey, which is a moved by the western particle of the rate to the same above as probability western particles of the accordance to the country to the features of the older valley. This point extends out nearly even with the beautifuls, which are on recteil by a long our range each

jowered to the shad rock, whire it has been head proctonity.

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A few of these Parafic streams have not yet; a upletely filled it er old valleys wate seaturent, and the unfalled partion of one now forces the barbor of Sen Juan et Sen. The Sen Juan over those the easier to the east the estarty which care occupied at valley, but has pushed the caset once gastword by a broad dettain and

The Sun Juan user and its valley bearsuch an intenute remtent any conditions about a some what nore letaled account of the enthur the short of property of the development. Of view, either with reference to the history of the development, the present observer to the carme and has as, or the pass of the of using a fair meanal route the San Juan valley is noturnly divided a to three sort ones. Starling from one point where the rever haves have Naturnagem, the first extends to the least of the Theorem is, the second from the heal of the Toronay distorts though of the San Carlos giver, and the girl of from the principle of the San Carlos giver, and the girl of from the principle

on the apperator the river has a moneyte current and a consideration of the lacks are low and swarpy, except where it awarps against the foot of carrief the trumerous has resepationed to additionally and through which it moundoes. It is exchient that the take for verly extended down to and beyond this partitional distribution among to formary has been reclaimed but the waters. It is were recognized that lakes are uplicated for these, and the order new very low which they are obliterated are after fixing from their appearance by the cutting down of mean orders. In this case, I owever, the first of these processes has been expensed. The press of the lake is long content of chartly by the right of these processes has been expensed. The press of the lake is long content of chartly by the right of the site is the

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y than the three-plants of its sense or truckers. the latter are probabil in their upper concess and many we note. are thus formed. From the weath of the San Carlos consurant the San June occupies the Part femiliar, an of the value of the g don it was direct times are now plant at ply of ton ering fate ashed by the annuliers or butteres and asso to the agreemental drift of the lators, exercit in the faribleons see. As the river extended as correct eastward by the Lagraful the earlier, and after by the formation of the destination, it was containably prow ted to the numbered by the rection of the said dock plong the most. This ten only been he more pronounces the factor or time acta was built, and the alarm nor oward be a of the lower bull John is is first consequence.

Applies equipment about the contract of artists and the contract party. the of the values when I be fided first are to a long medevel than the gondrein parties. The over would thus at times has dead in a position of trastable operatorion, and would seek a new elimine, on the lower part of the deltaplan to the southware. I'll as it is proportion that the river singular y one spred due presents. , where of the Burnillo. We see that position because a restable it you holy desired is a whom channel for the present position of the I were sandapp. Sales of costly the latter became mark! e. and a more favora do comme to the sea was for all stanforther sept. The recent channel of La Col mac was bedeveloped at the expense of the lower ban June, This process estal government the restors accounts of water correct by the two characterists and very restores, victamized within a go intation. It less not fleadly more fied, the I were San Jana we conthe ir to dwin a dine a probably me the water well find its way to the sea by the Colorado or system in the favorably located or annel sail first er souch.



## NICAHALI A AND THE STHM AN ROUTES

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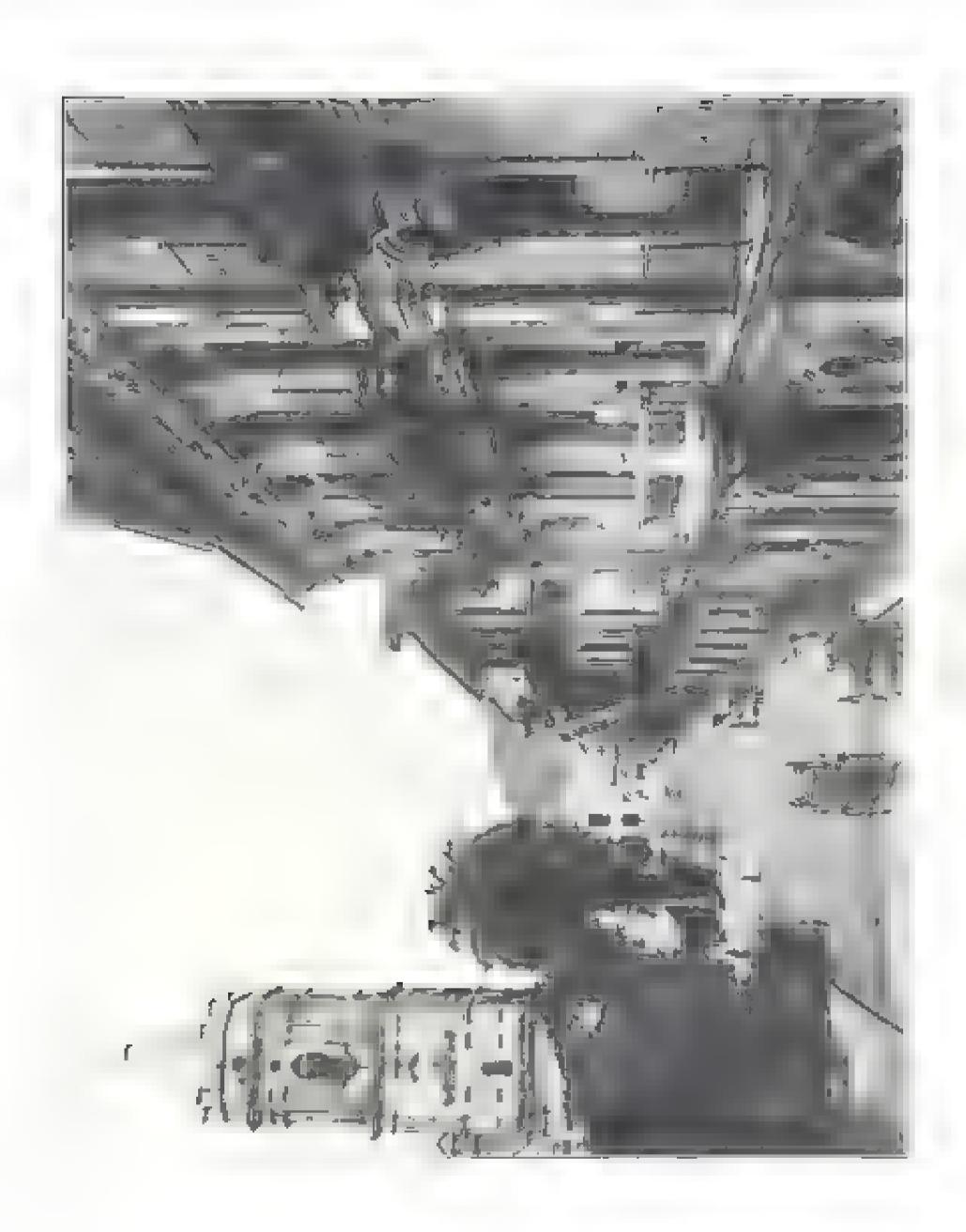
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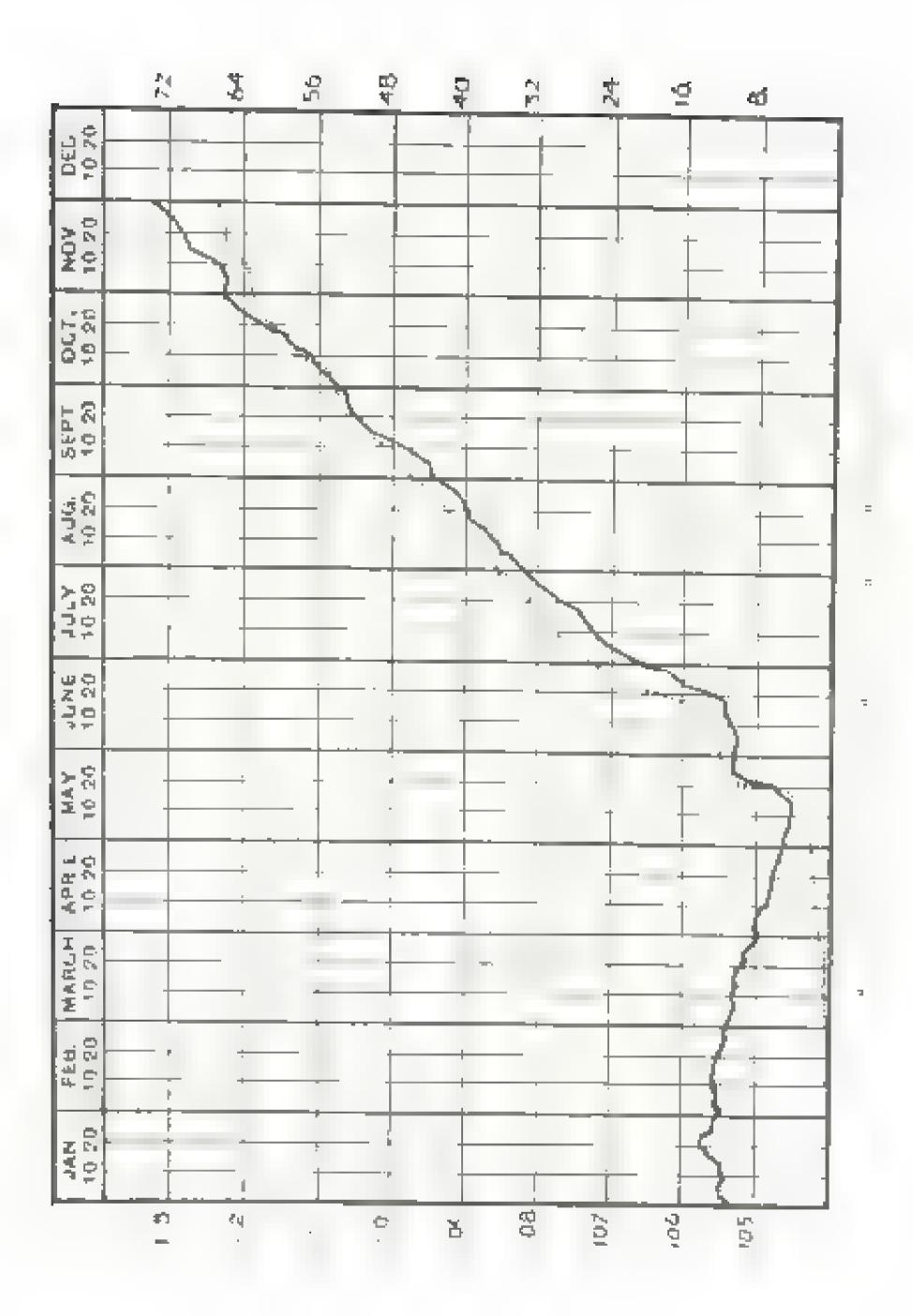
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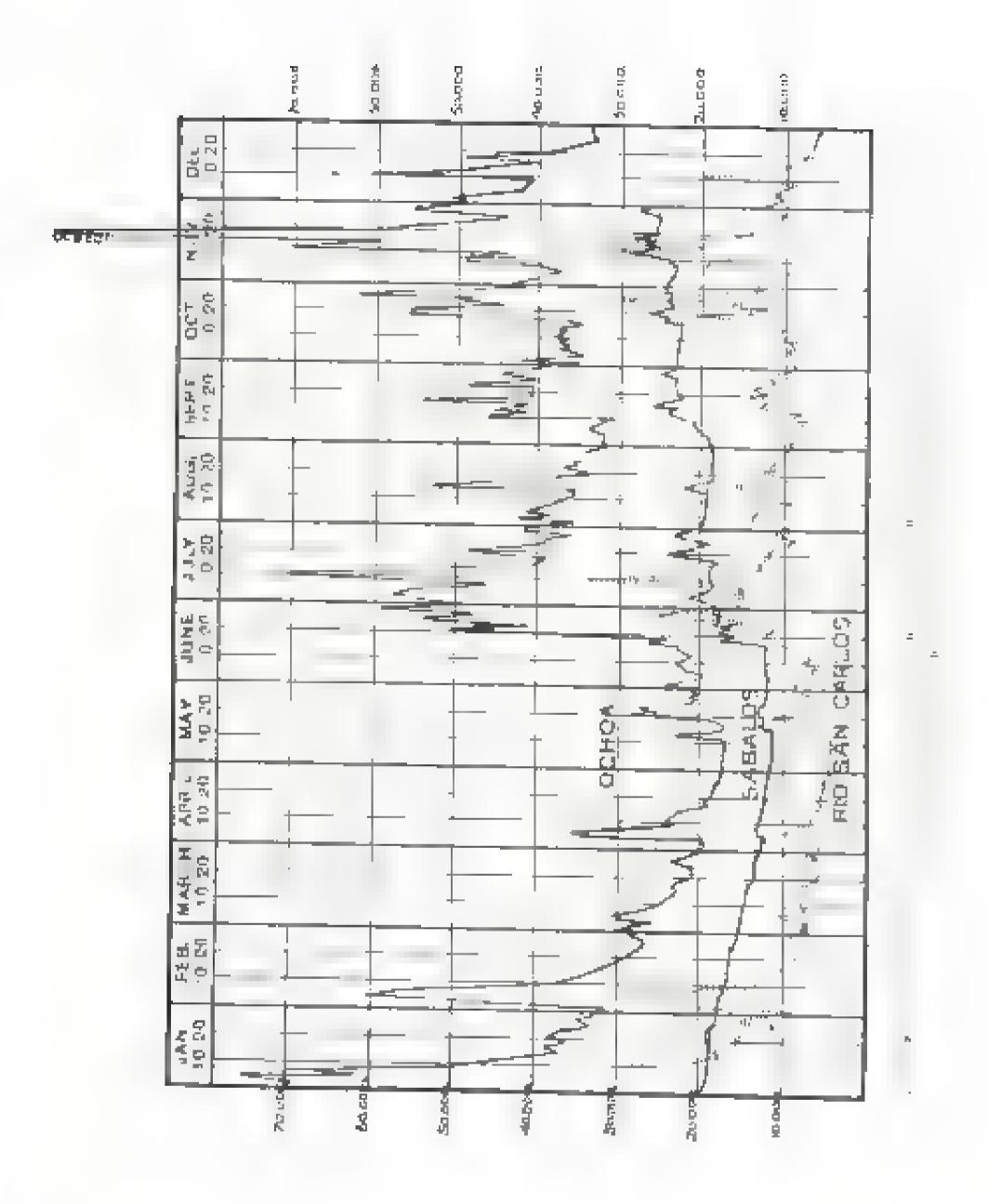
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#### GEOGRAPHIC LITERATURE

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